Introduction to EMG

What it is and why do we need it?

Roger Kasendorf, DO

PM&R/Pain Management

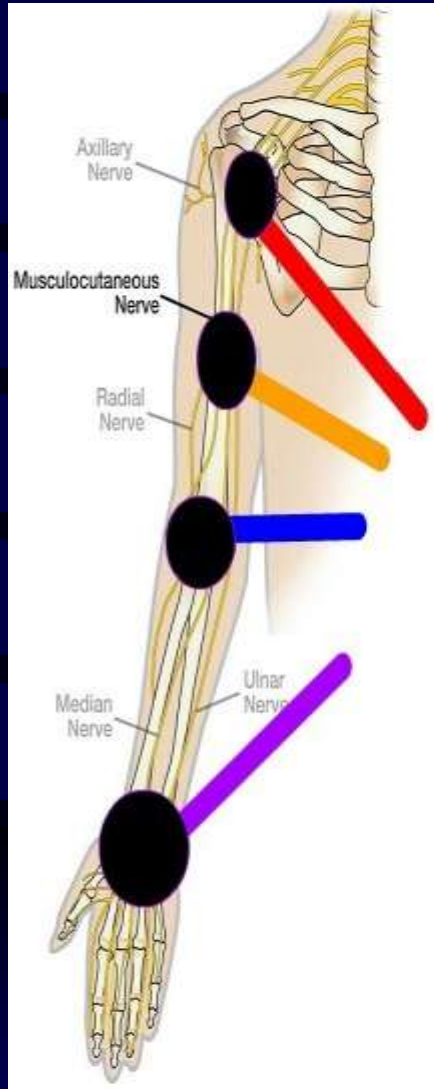
QME, AME

Electromyography

- Electromyography (EMG)
  - Recording the electrical activity of muscles
- Nerve Conduction Studies (NCS)
  - Assessing the way peripheral nerves conduct action potentials

Why Do EMGs?

- Location of injury
  - Anterior horn cell, nerve root, plexus, peripheral nerve, NMJ, muscle, sensory nerve
  - Precise localization along these pathways



UPPER EXTREMITY NERVE INJURIES

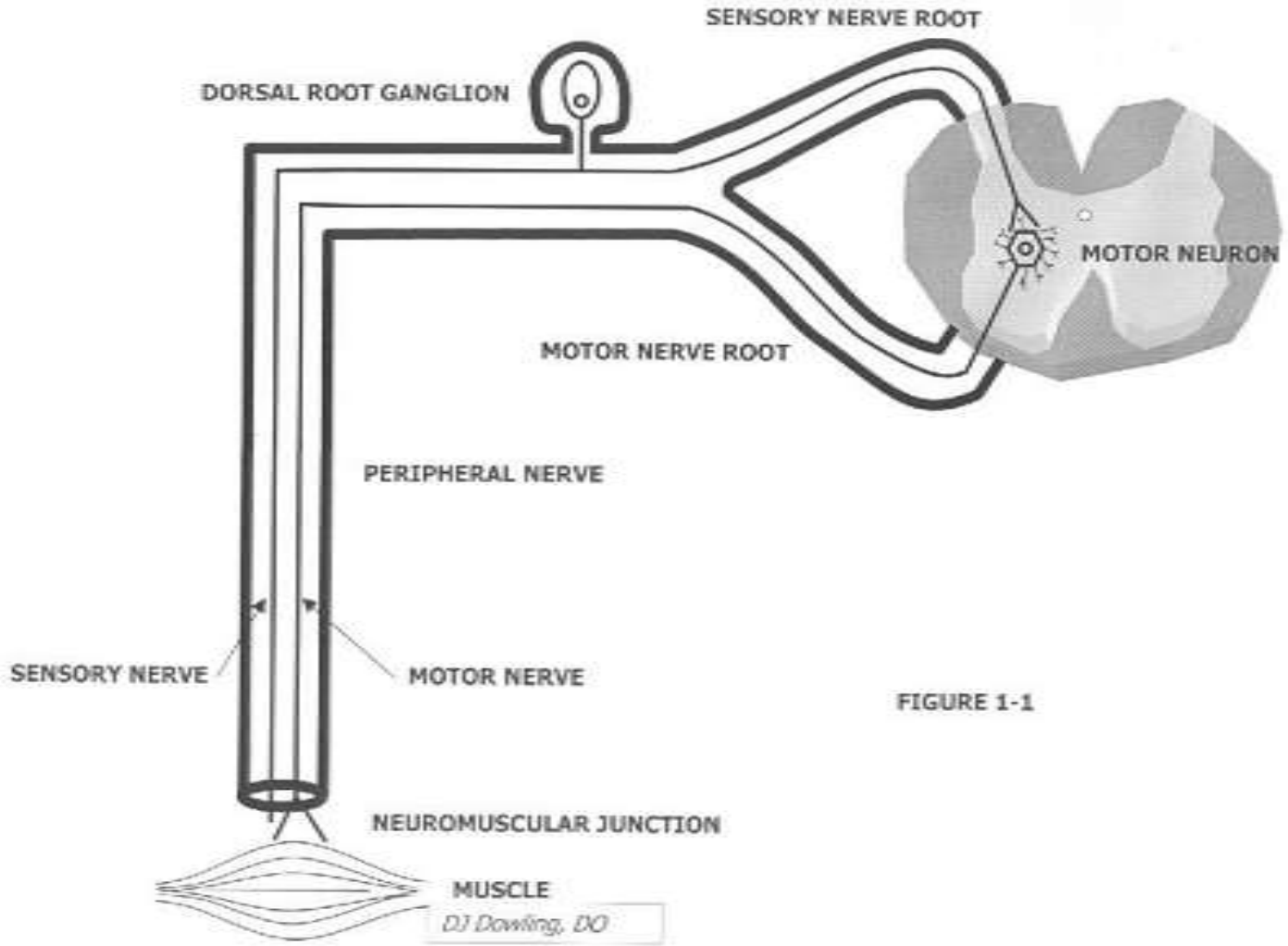

SENSORY NERVE ROOT
DORSAL ROOT GANGLION
MOTOR NEURON
MOTOR NERVE ROOT
PERIPHERAL NERVE
SENSORY NERVE
MOTOR NERVE
NEUROMUSCULAR JUNCTION
MUSCLE
DJ Dowling, DO

FIGURE 1-1

Why Do EMGs

- Confirm or rule out a suspected diagnosis
- Assess for nerve and or muscle injury
- Assess **severity** of injury
- Prognosticate
- Assess age of injury

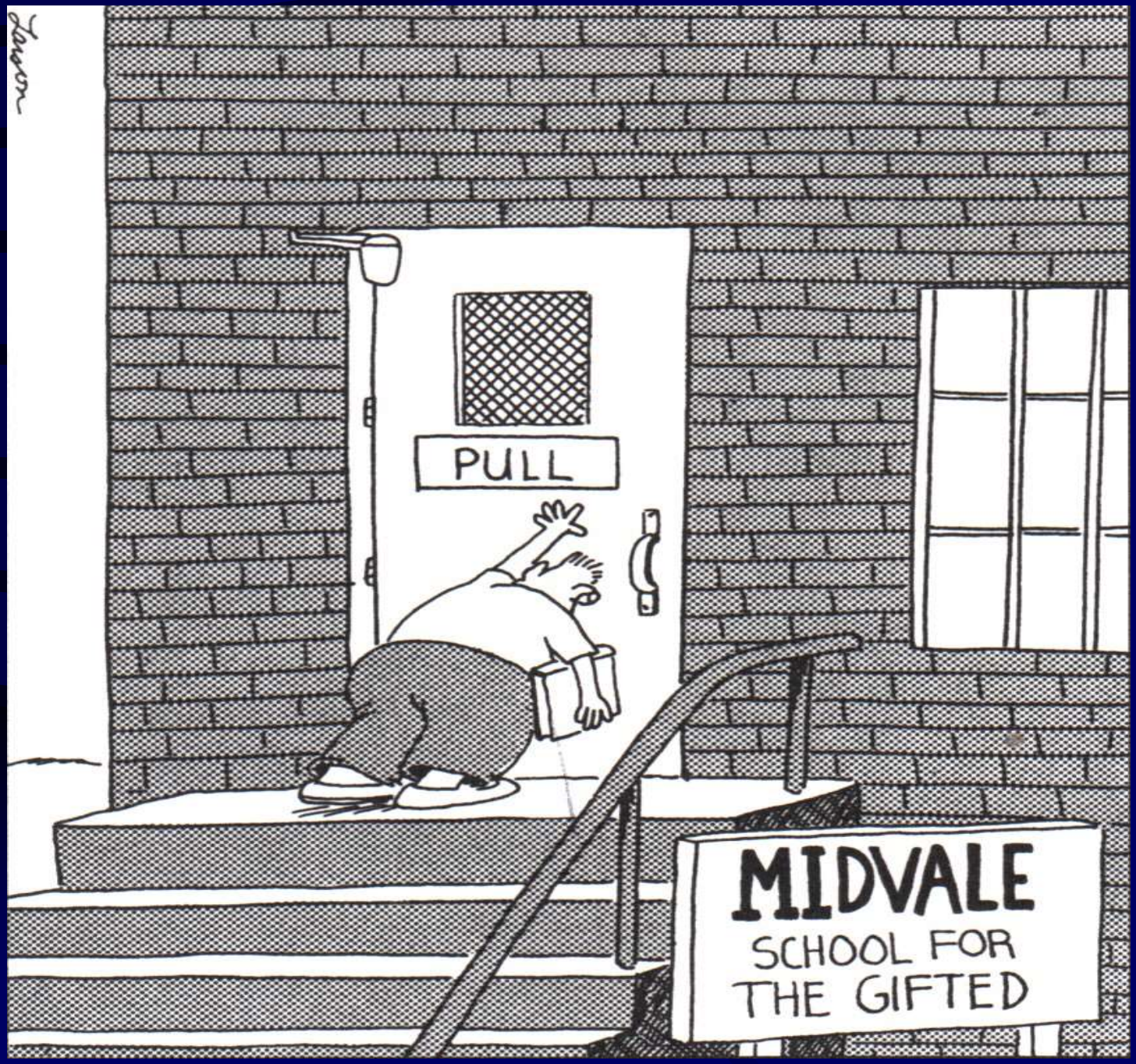
Anatomy vs Physiology

- Imaging studies (X-ray, CT, MRI) give **anatomical** information
- EMGs give **neuro-physiologic** information
- EMGs and imaging studies often complementary

Anatomy vs Physiology

EMG is an Extension of the Physical Examination

- Must include physical examination and medical history.
- H&P to guide the examination
- Essentially should be done by DOCTOR, not technician.


PULL
MIDVALE
SCHOOL FOR
THE GIFTED

Contraindications to EMG Testing

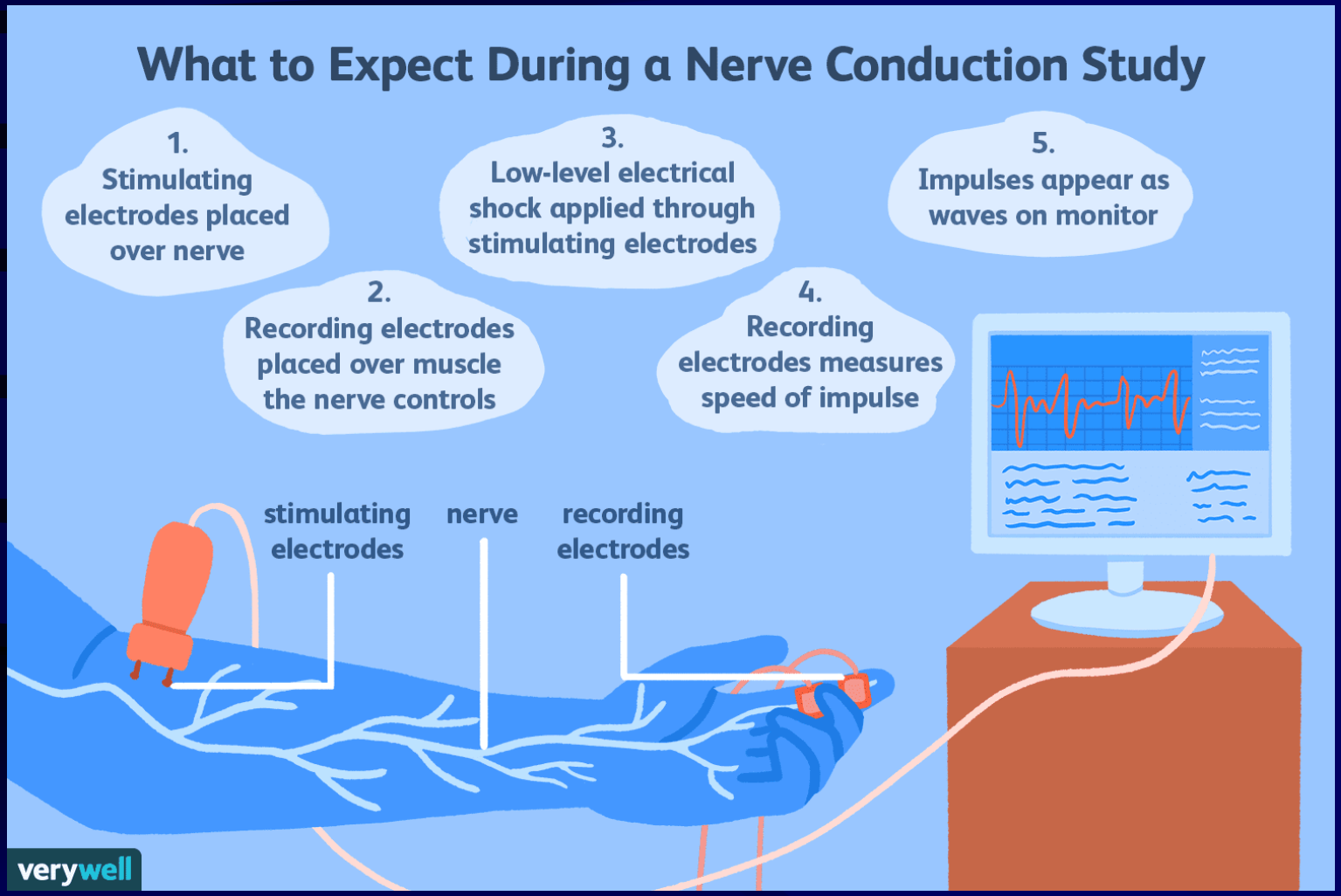
- Cellulitis
- External pacemaker (if stimulating Erb's point)

Not a Contraindication

- Mastectomy
- Anticoagulation
- Joint replacement
- HIV/Hepatitis (always use universal precautions)

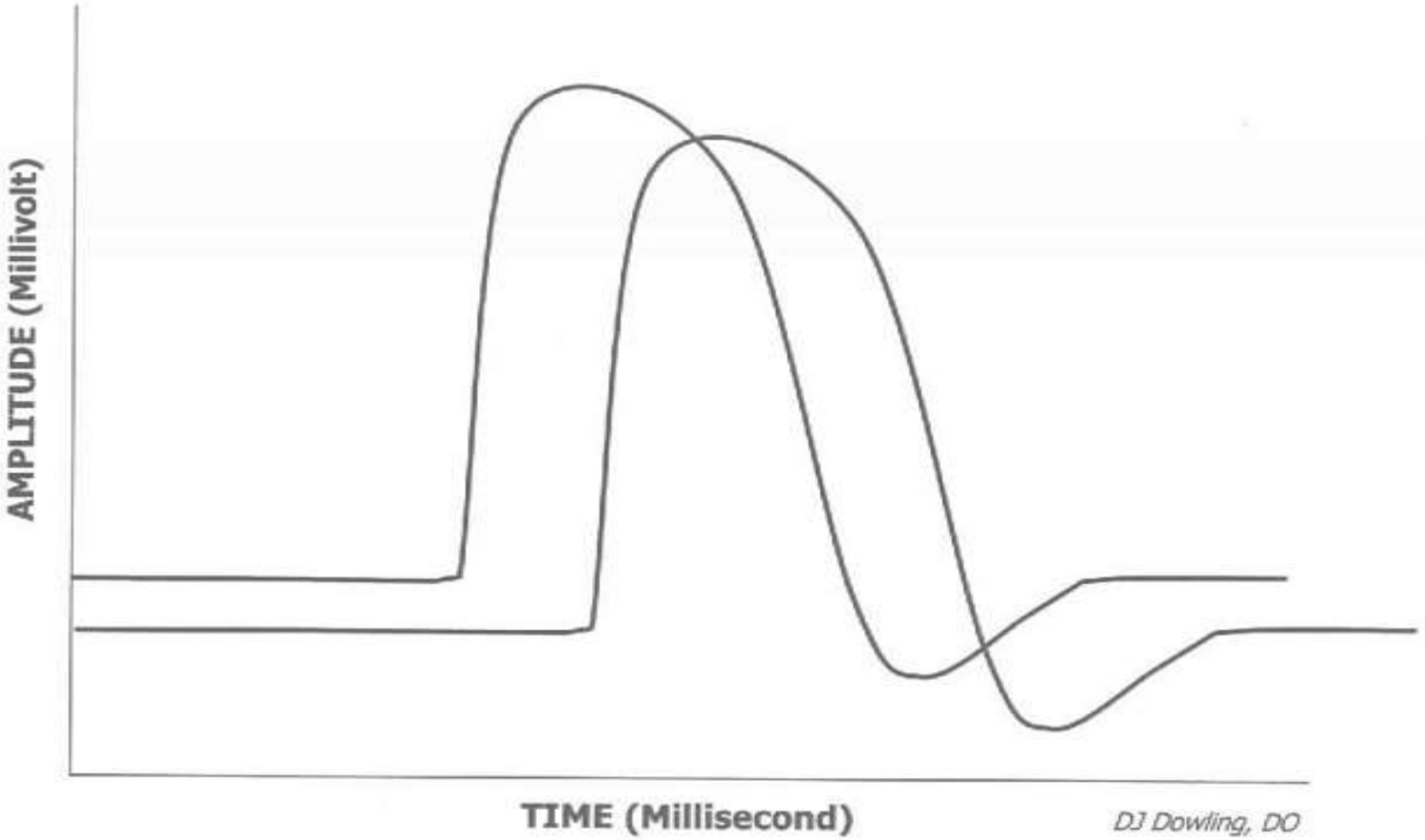
Nerve Conduction Studies

- Can assess motor or sensory nerves (not autonomic nerves)
- Place electrode over muscle (motor nerve) or dermatome (sensory nerve) and electrically stimulate the nerve
- Assess SPEED and INTEGRITY of Nerves


What to Expect During a Nerve Conduction Study
1. Stimulating electrodes placed over nerve
2. Recording electrodes placed over muscle the nerve controls
3. Low-level electrical shock applied through stimulating electrodes
4. Recording electrodes measures speed of impulse
5. Impulses appear as waves on monitor
stimulating electrodes
nerve
recording electrodes
verywell

Nerve Conduction Studies

- Latency
- Amplitude
- Conduction Velocity



NORMAL

FIGURE 6-5

Latency

- The time (in milliseconds) for a nerve stimulation to reach the recording electrode
- Depends on the distance that the stimulation is from the recording electrode

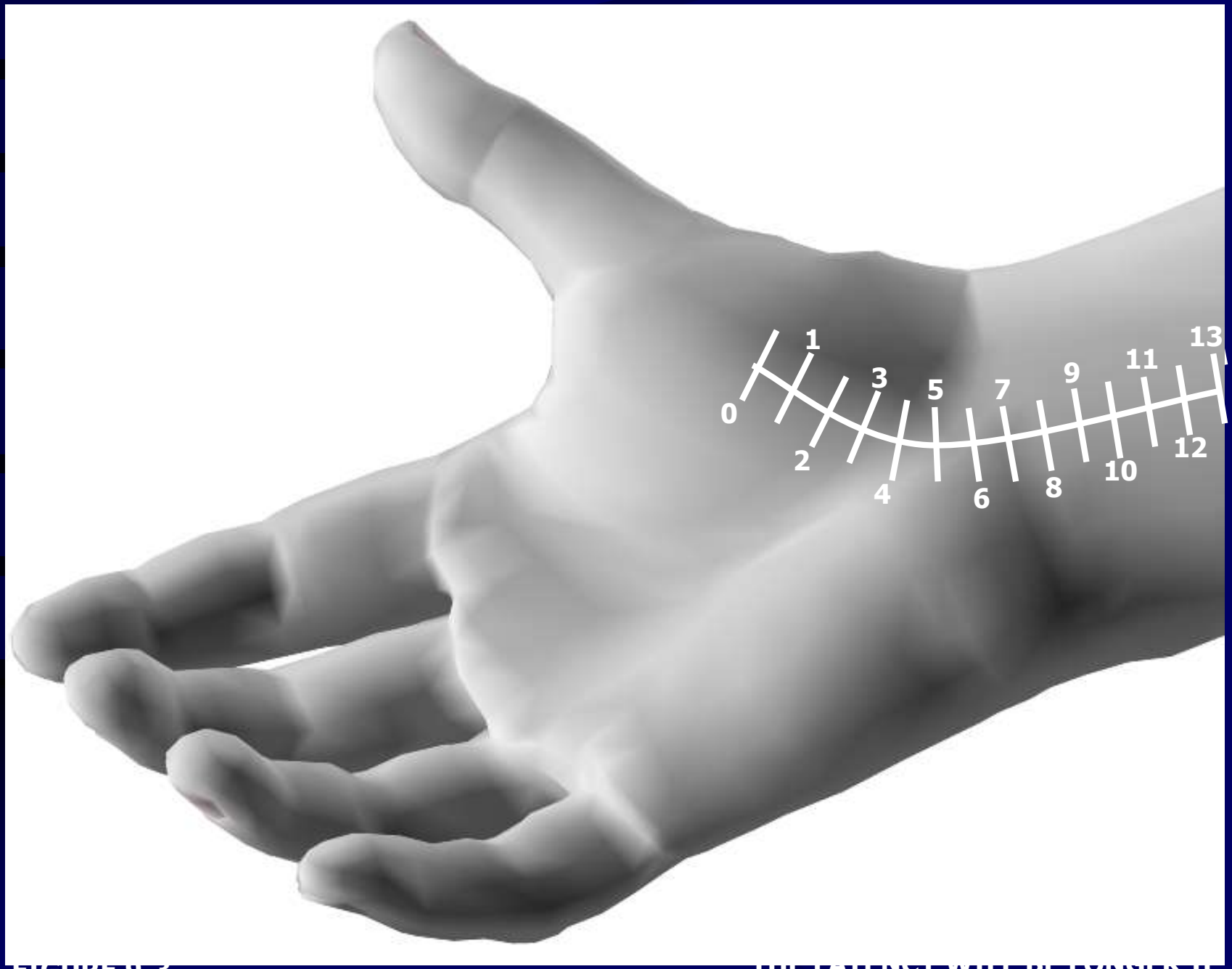
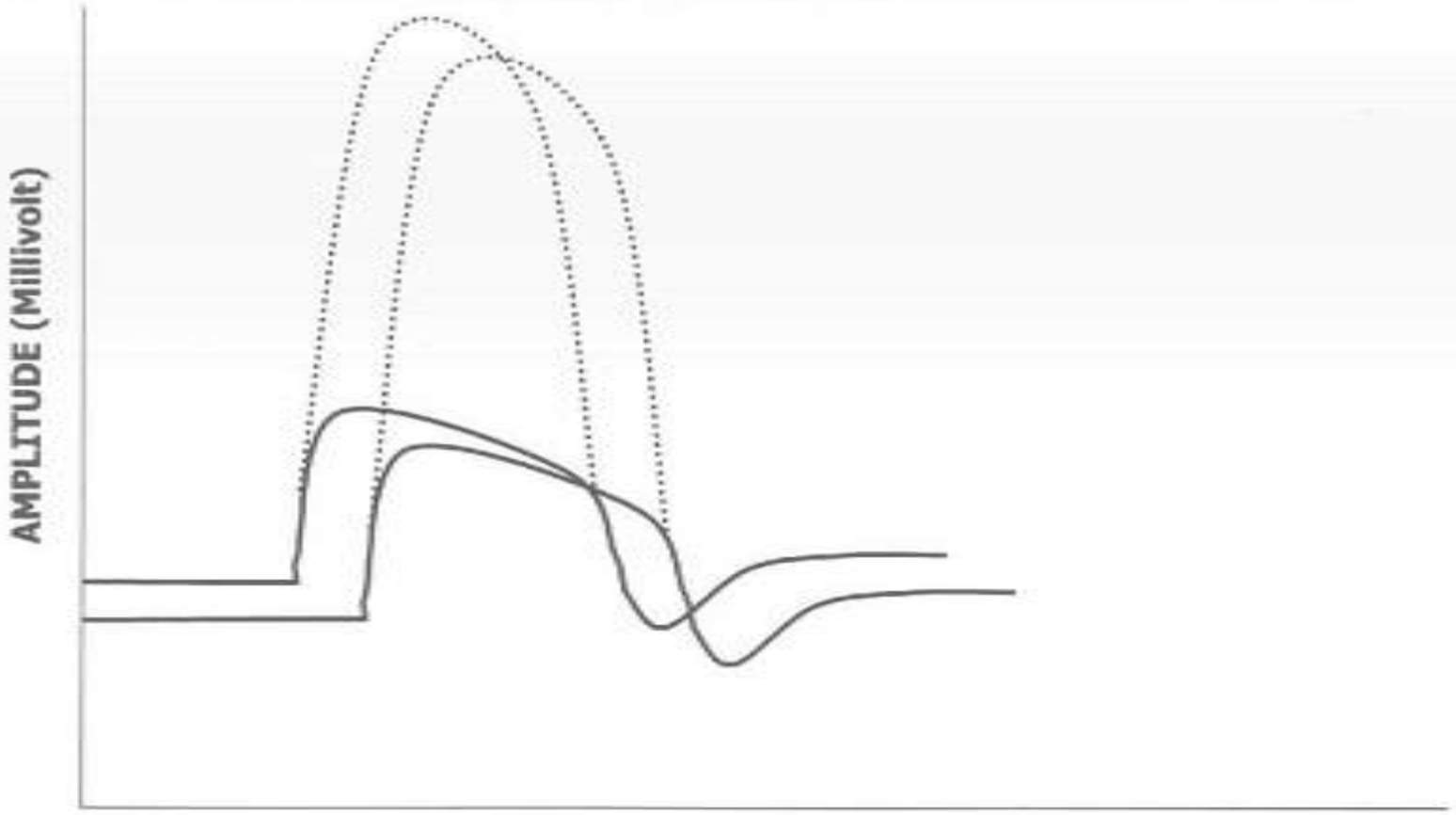


FIGURE 9-3

THE LATENCY WILL BE LONGER IF THE DISTANCE IS GREATER

Amplitude

- Recorded in millivolts (motor) or microvolts (sensory)
- Looks at height of evoked response
- Reflects the number of axons contributing to the response
- Don’t be fooled by dispersion



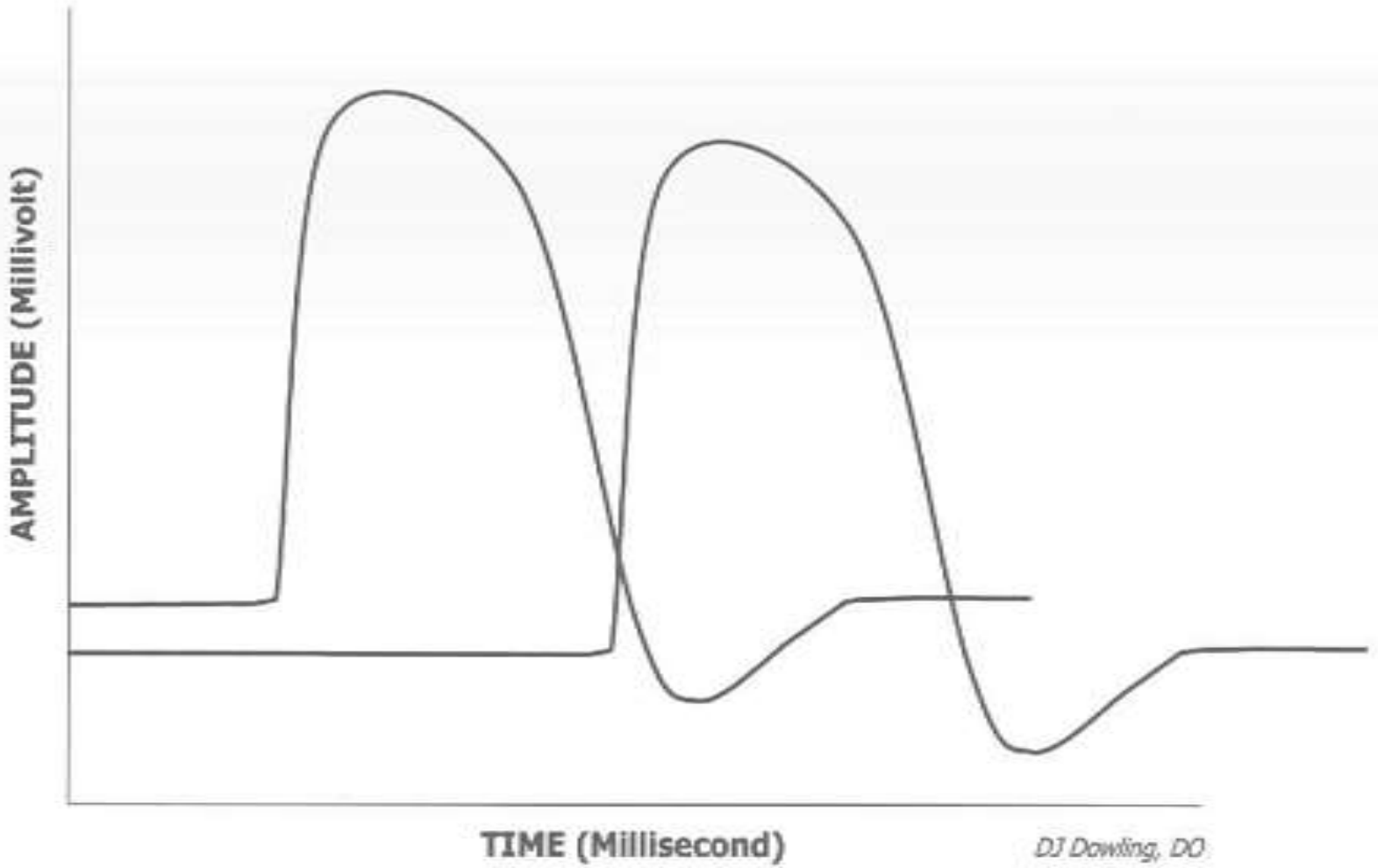
AXONAL NEUROPATHY

(DOTTED LINE INDICATES NORMAL AMPLITUDE)

FIGURE 6-4

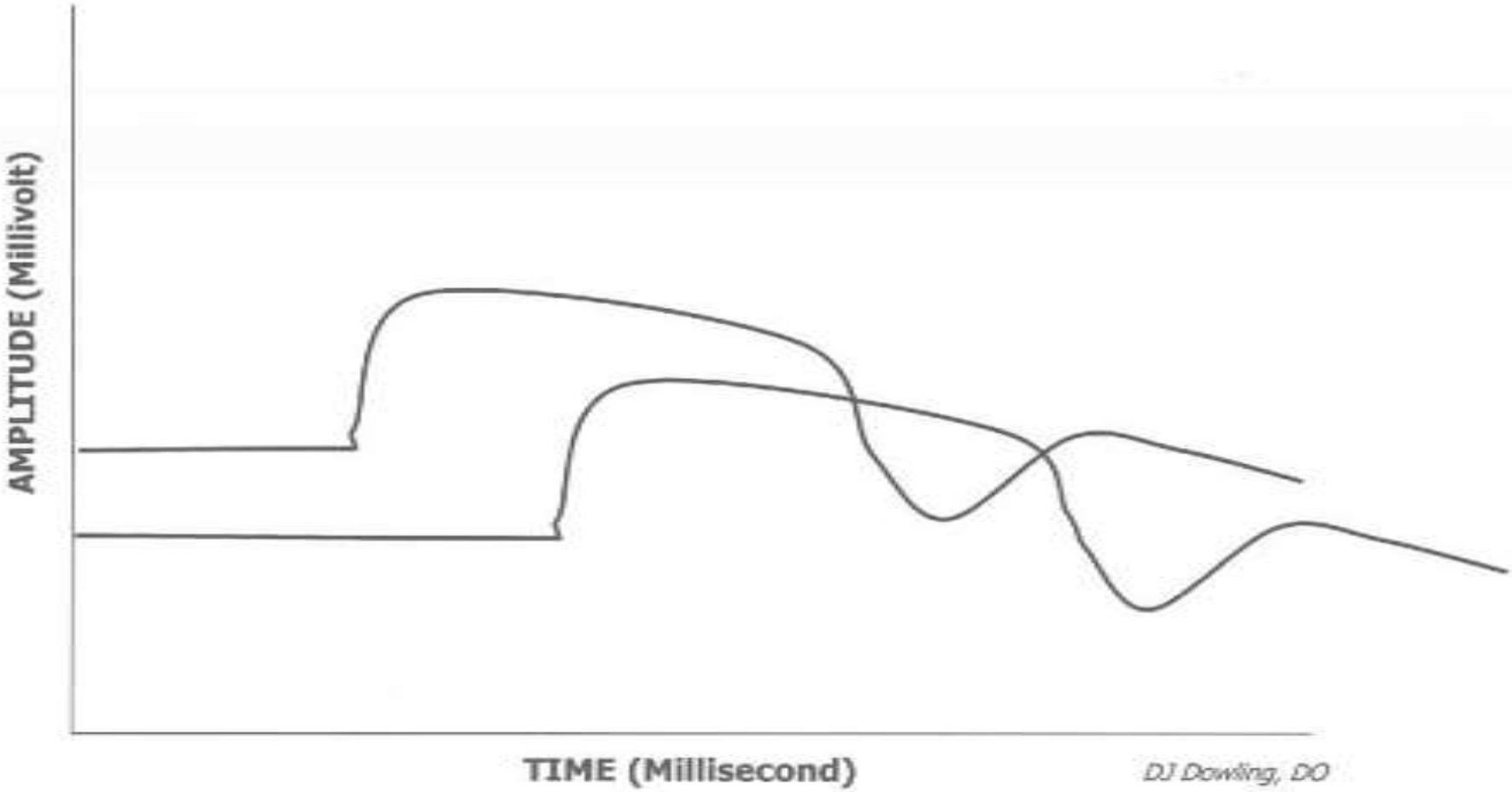
Conduction Velocity

- Velocity = Distance/ Time
- Measured in meters / second
- In sensory nerves, no myoneural junction so velocity is directly related to distance
- In motor nerves, there is a myoneural junction. Therefore, have to stimulate 2 nerve segments
- Conduction velocity is related to integrity of myelin



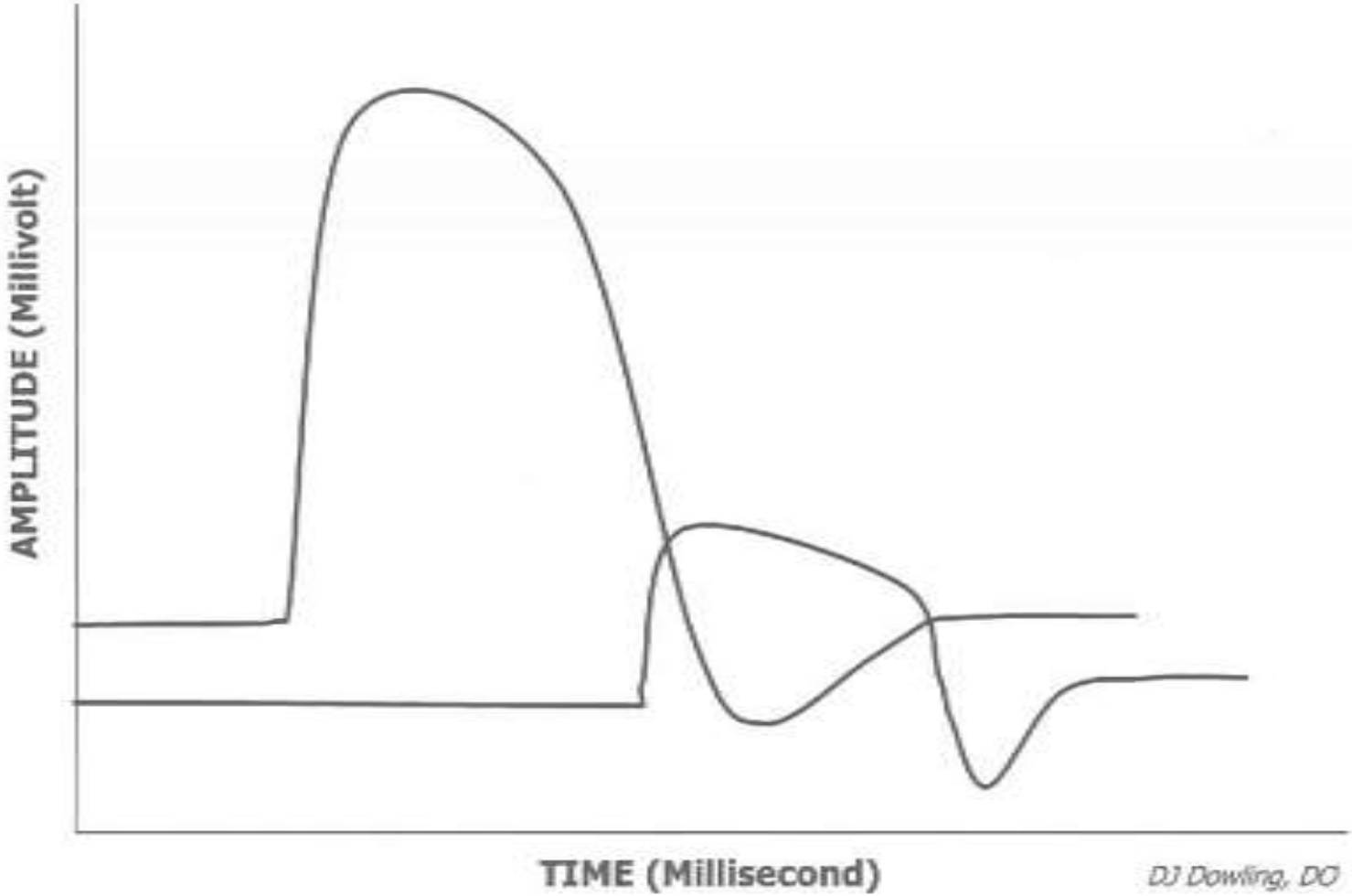
FOCAL NERVE SLOWING

Figure 6-2



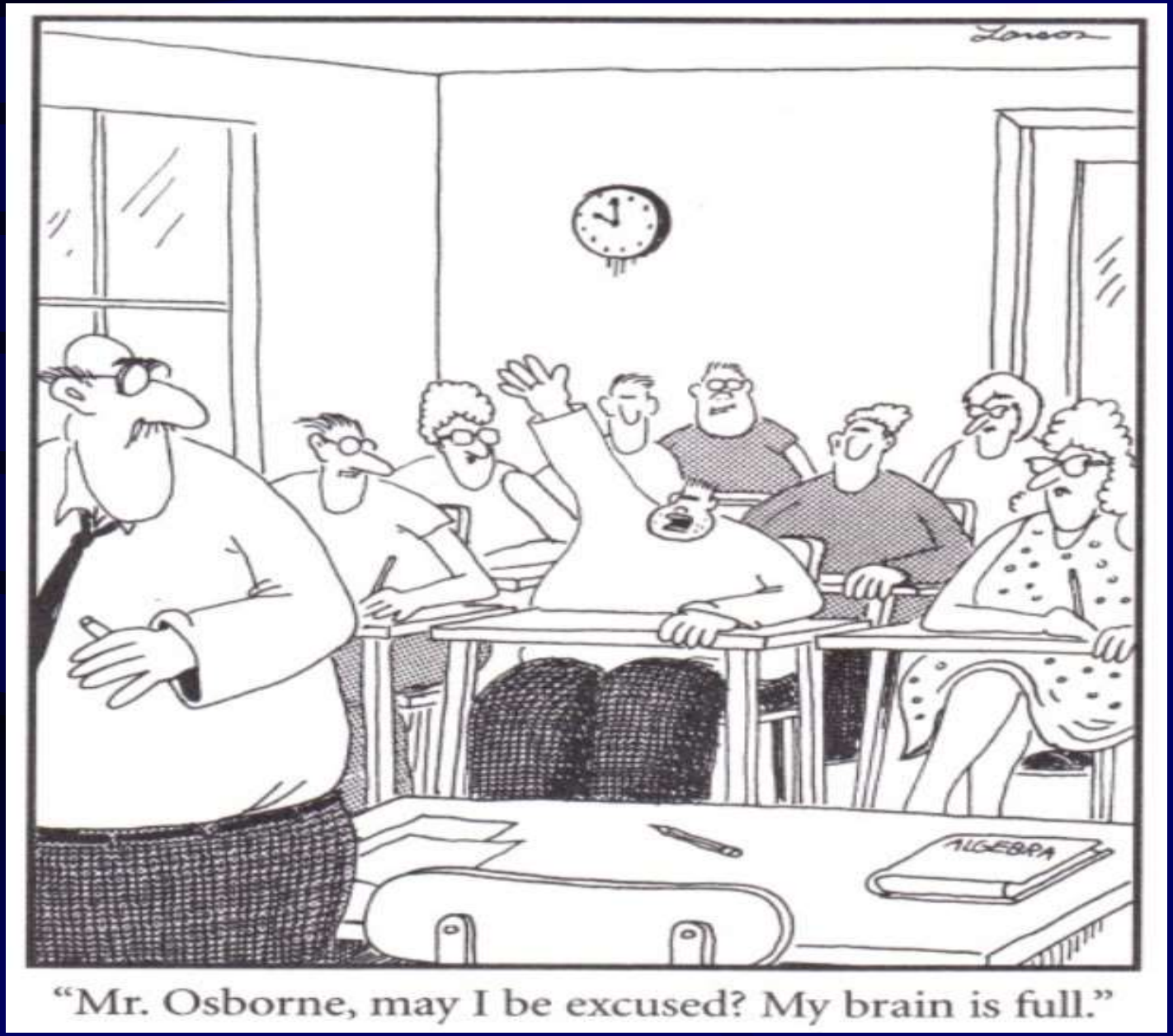
SEGMENTAL DEMYELINATION

FIGURE 6-1



CONDUCTION BLOCK

Figure 6-3



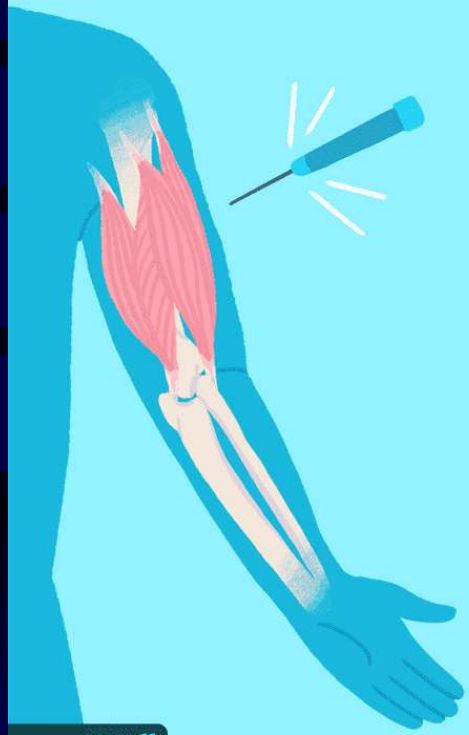
"Mr. Osborne, may I be excused? My brain is full."

Needle EMG

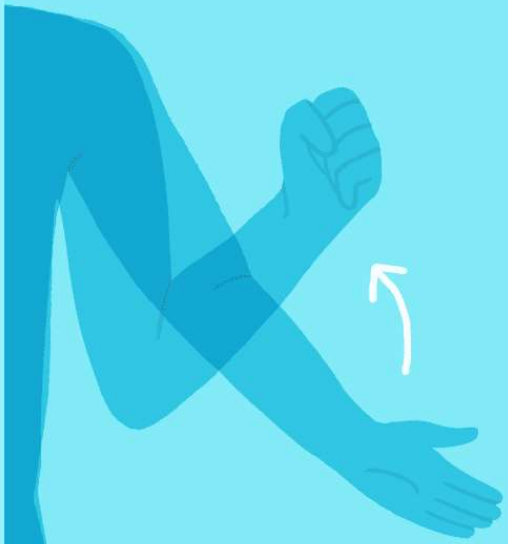
- Insertional Activity
- Activity at Rest
- MUAP (motor unit action potential) morphology
- Recruitment

What to Expect During an Electromyography Test

1. Needle electrode inserted into muscle



2. Neurologist tells you when to contract and rest muscle



3. Needle records muscle activity during rest and movement

verywell

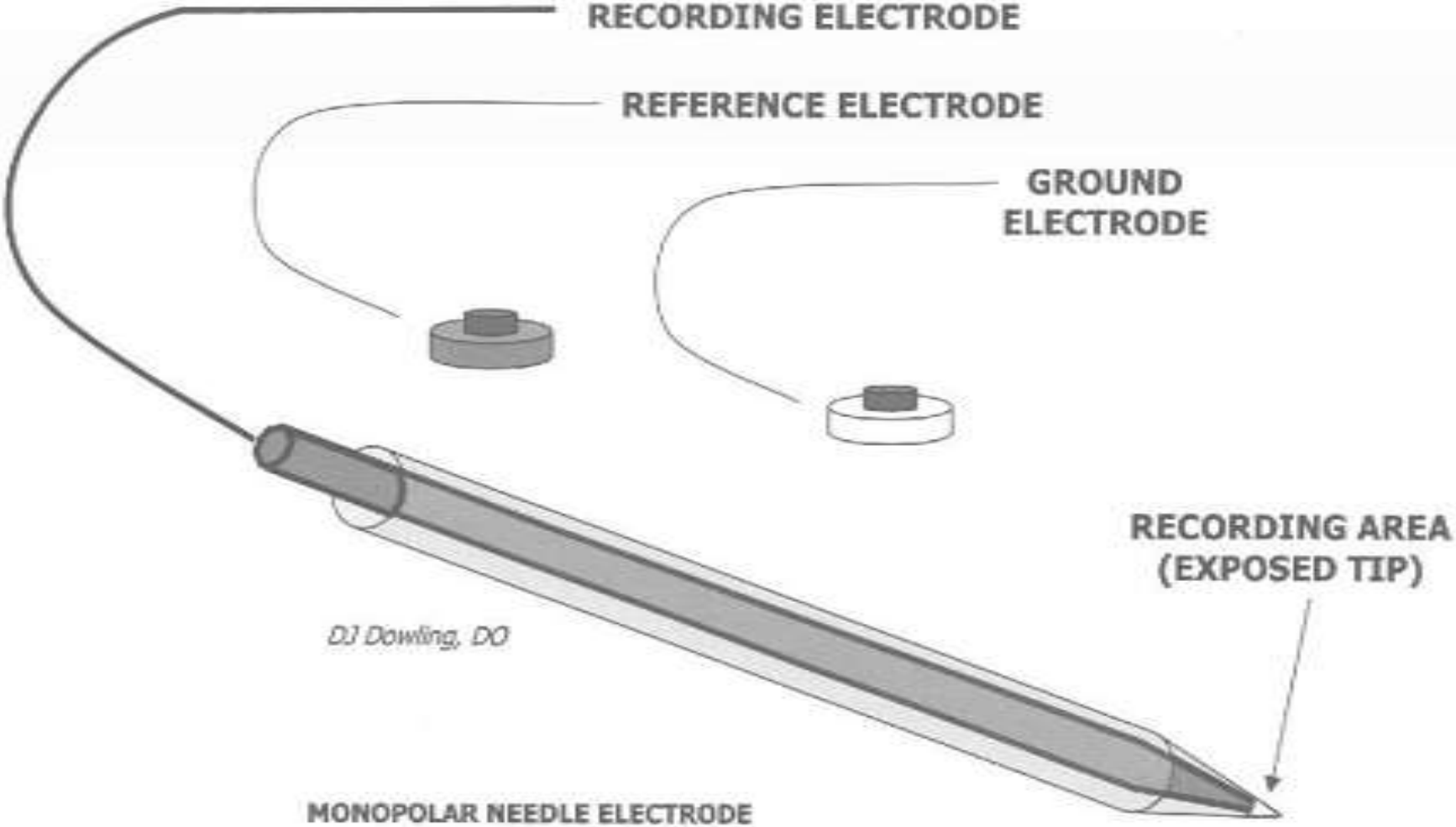

RECORDING ELECTRODE
REFERENCE ELECTRODE
GROUND ELECTRODE
RECORDING AREA (EXPOSED TIP)
DJ Dowling, DO
MONOPOLAR NEEDLE ELECTRODE

FIGURE 5-16

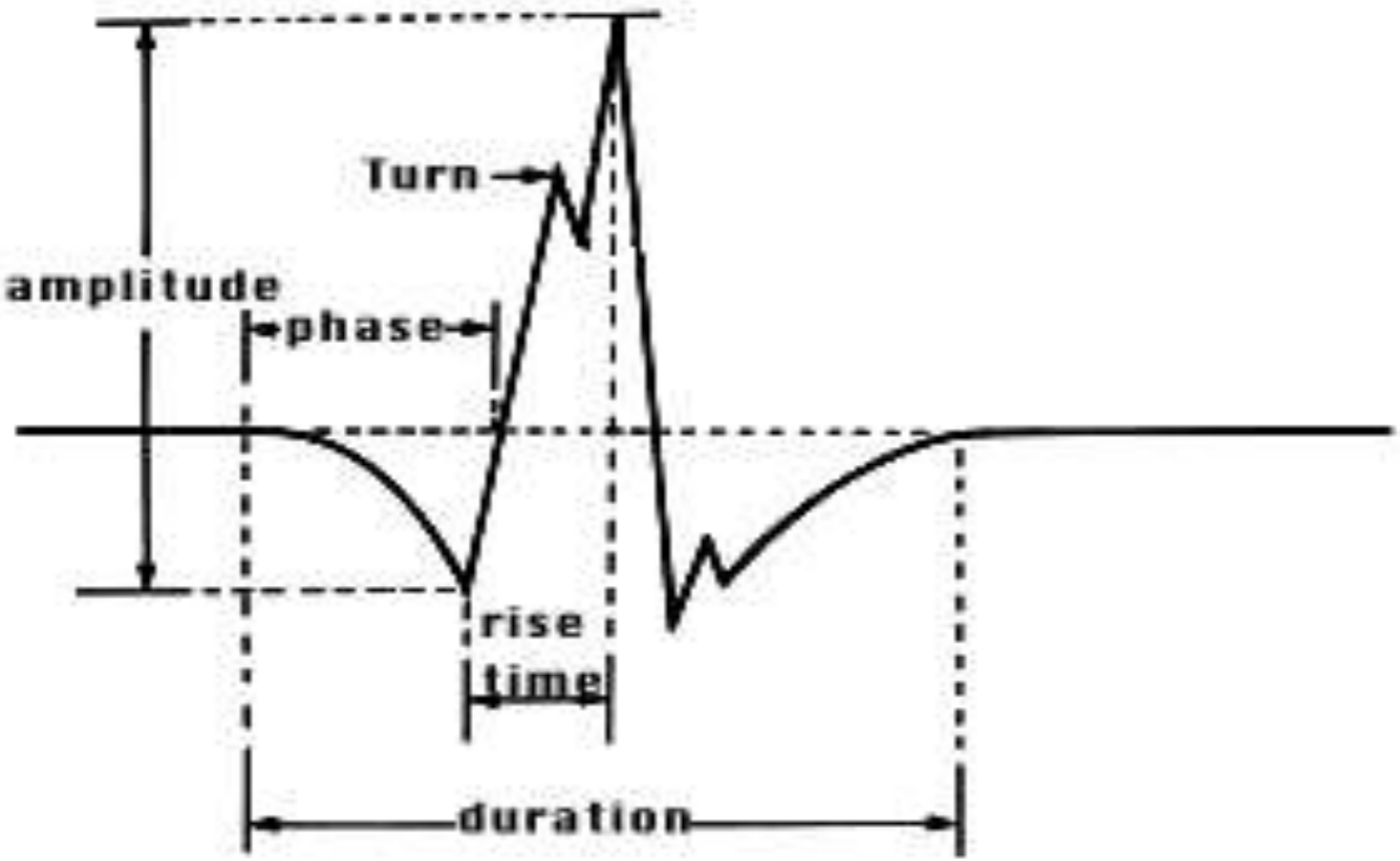
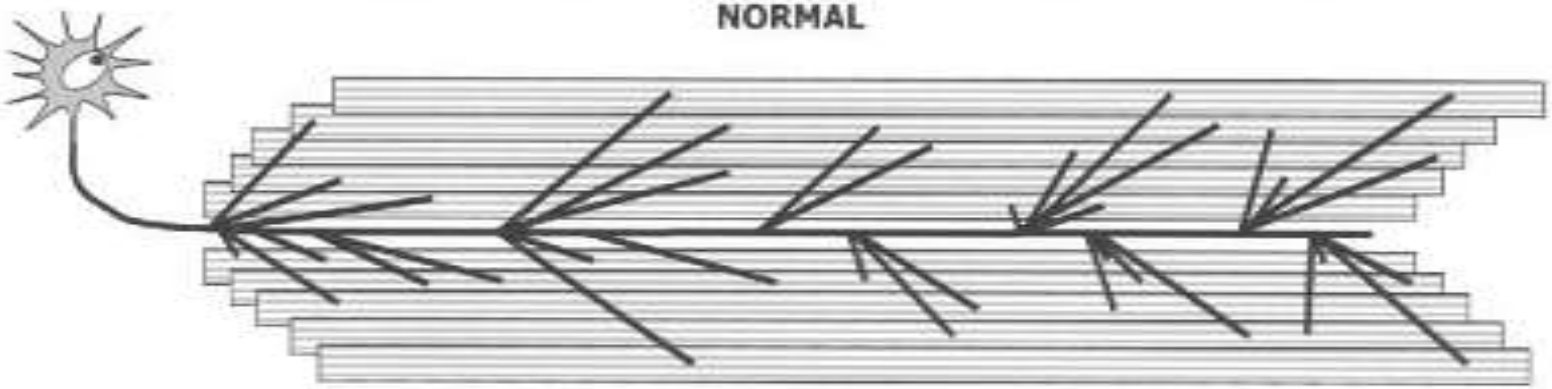
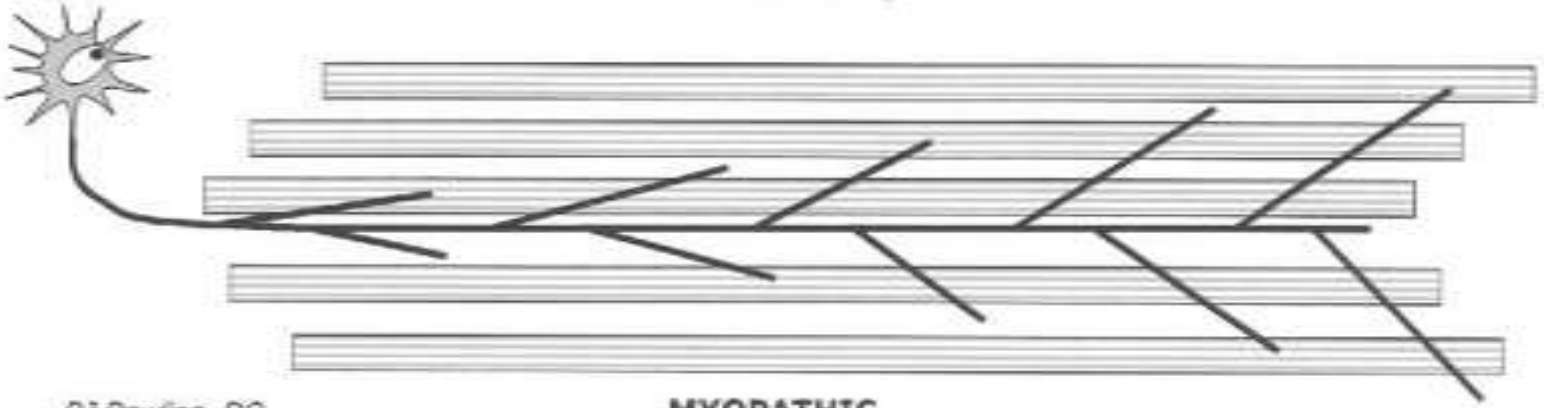

Turn
amplitude
phase
rise
time
duration

FIGURE 5-12

NORMAL



NEUROPATHIC



MYOPATHIC

DJ Dowling, DO

Limitations of EMGs

- The electromyographer (biggest limitation)
  - Know your anatomy!
- Can not assess CNS (unless doing SSEPs) or small fibers
- Patient tolerance
- Normal EMG
  - Test done too early
  - Non-neurogenic abnormality

Significance of a Negative EMG

- Test done too early
- Appropriate muscles and/or nerves not tested
- Test interpreted incorrectly
- Nidus of pain would give a negative EMG
- Not a significant amount of acute or chronic nerve damage in areas tested

Conditions That Would Yield a Negative EMG

- Degenerative Joint Disease
- Facet disease
- Rheumatoid Arthritis
- Osteoporosis
- Fractures
- Sprains
- Sensory only Radiculopathy

Conditions That Would Yield a Negative EMG

- Spondylolisthesis
- Scoliosis
- Bursitis
- Fibromyalgia
- Myofascial Pain
- Pregnancy
- Vascular disorders
- Psychogenic disorders

Timing of the EMG

- 4-5 days for degeneration of the nerve distal to an axonal injury (may have normal NCS in first few days)
- 1-3 weeks to see spontaneous potentials on needle testing

Types of Nerve Injury

- Demyelination
- Neurapraxia
- Axonotmesis
- Neurotmesis

The EMG Machine